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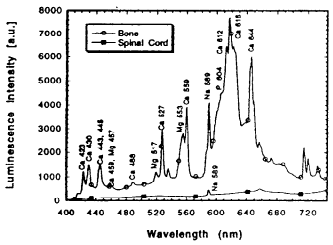
LUMINESCENCE SPECTROSCOPY FOR FEEDBACK CONTROL DURING ULTRASHORT PULSE LASER TISSUE ABLATION

B.-M. Kim, M. D. Feit, A. M. Rubenchik and L. B. Da Silva
Lawrence Livermore National Laboratory, Livermore, CA

Ultrashort pulse lasers (USPL, <1 ps) have shown considerable promise to be effective and reliable tissue ablation tools with minimal collateral thermal/mechanical damage. Since the ablation rate is approximately 1 μm/pulse using USPL, a high rep rate system is needed to make these systems a practical surgical tool. Therefore, to accurately control the ablation process, it is desirable to have the laser system equipped with a smart control mechanism. In our study, we have shown that luminescence spectroscopy from the plasma produced during USPL ablation can be used as an effective feedback signal during spinal surgery. Fig. 1 compares the luminescence spectra from porcine bone and soft tissues. The ratio of luminescence intensities at 615 nm and 575 nm are 4.8 for bone and 1.4 for spinal cord independent of the absolute intensity. A real time feedback system was constructed which monitored the ratio on each laser pulse and, based on the value, either continued to fire or stopped the laser. This system allowed us to safely ablate bone tissue with minimal or no damage to adjacent soft tissue. Details of these experiments and a discussion of the results will be presented.



* Work performed at Lawrence Livermore National Laboratory under the auspices of the U.S. Department of Energy under contract No. W-7405 -ENG-48.

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THE QUALITY OF LIFE OF PATIENTS WITH BENIGN MENINGIOMA TREATED MICROSURGICALLY WITH THE CO^2 LASER

Cinthia Leman[1], James Grutsch[1,2], Faith Davis [2],
Edward Mkrdichian[1], Leonard Cerullo[1]
1. Chicago Institute of Neurosurgery and Neuroresearch,
2. University of Illinois at Chicago

A cross-sectional study was conducted to assess the quality of life at one year or more after surgery of patients with benign meningioma who were treated with one microsurgical resection with the CO^2 laser at the Chicago Institute of Neurosurgery and Neuroresearch. Cases included 86 patients treated at CINN between January of 1988 and June of 1995. Information was collected on tumor and patient characteristics as well as surgery details by medical record reviews for all patients. Data on demographic variables, presurgical symptoms, past and current medical conditions, depression and quality of life was collected for all patients through self-administered mailed questionnaires. The instrument used to measure depression in this study was the depression scale developed by the Center for Epidemiologic Studies on Depression (CES-D). The instrument used to evaluate the quality of life of patients was the Functional Assessment of Cancer Therapy-Brain Subscale. Results indicate that 80% of benign meningioma patients surgically treated with the CO^2 laser have little or no symptoms of depression. Approximately 70% of patients reported scores which indicate a high level of physical, social/family, emotional, and functional well-being, relationship with doctor, brain specific and total quality of life. Approximately 20% of patients scored in the range suggesting a fair quality of life in each domain with the presence of some symptoms and impairments. 10% of patients had scores reflecting low or very low levels with severe impairments. Income, smoking history, marital status, and education were independently related to different aspects of quality of life and depression. From this study, it can be concluded that the majority of patients with benign meningioma who are treated surgically with the CO^2 laser experience a high level of quality of life and low level of depressive symptoms at one year or more after surgery.

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LASER DIAGNOSIS AND TREATMENT OF DEEP-SEATED BRAIN LESIONS

Helen Anne Ward
Medical Health and Research Centre, Randwick NSW 2031 Australia

The five year survival rate of deep-seated malignant brain tumours after surgery/radiotherapy is virtually 100% mortality. Special problems include: (1) Lesions often present late; (2) Position - lesion overlies vital structures, so complete surgical/radiotherapy lesion destruction can damage vital brain-stem functions; (3) Diffculty in differentiating normal brain from malignant lesions.

The aim and method of this study was to use the unique properties of the laser: (a) to minimise damage during surgical removal of deep-seated brain lesions by operating via fine optic fibres; and (b) to employ the propensity of certain lasers for absorption of (non toxic) dyes and absorption and induction of fluorescence in some brain substances, to differentiate borders of malignant and normal brain, for more complete tumour removal. The project resulted in a fine laser endoscopic technique for removal of brain lesions, which minimised thermal damage and shock waves. A compatible endoscopic fluoroscopic laser technique was developed. This differentiated brain tumour from normal brain.

It was concluded that by utilising special properties of coherent light wavelengths, a more precise, less damaging technique for laser removal/diagnosis of brain tumours was achieved.

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INTERACTIVE IMAGE GUIDED RESECTION OF CEREBRAL ARTERIOVENOUS MALFORMATIONS

Lucia Zamorano, Amgad Matter, Fernando G. Diaz
Wayne State University, Neurological Surgery Department, Detroit, Michigan

Introduction: Surgical excision is the only method to prevent immediately, further morbidity or mortality as a result of hemorrhage from arterio-venous malformations (AVMs). For those lesions located deeply within the cerebral hemispheres or near eloquent areas, conventional surgical resection may be associated with an unacceptable morbidity and mortality. In the present study we report our experience in the resection of these lesions using interactive image guidance. Material and Methods: From July 1992 to December 1996, 10 patients underwent interactive image guided excision of their lesions. Five patients were female (50%) and five male. Age ranged from 16 to 73 years (mean 41). Clinical presentation included hemorrhage (n=8) and headache (n=2). All lesions were classified using the Spetzler-Martin grading system: Grade 1 (n=4), Grade 2 (n=5), Grade III (n=1). The location of the lesion was as follows: Frontal (n=4), Parietal (n=3),Temporal (n=1),Occipital (n=1), Cerebellar (n=1).All patients underwent neuroimaging studies (CT, MRI, DSA) done under stereotactic conditions, prior to the surgical procedure. Surgical planning was carried out using the NSPS (developed at Wayne State University). An infrared-based system was used to define intraoperatively

the nidus, the feeding arteries, draining veins, and their relations with functional areas. For those lesions located near or within eloquent areas (n=6) an awake craniotomy with functional cortical subcortical mapping was performed. Clinical follow-up ranged from 3 to 62 months (mean 27). Results: In all patients complete surgical excision was achieved as demonstrated by digital substraction angiography postoperatively. The preoperative neurological status remain unchanged in 7 (70%) patients and improved in three (30%). There was no associated morbidity and mortality with this technique. Conclusions: Image guided surgical resection of AVMs represents a valuable technique, especially in small, deeply located lesions and those near eloquent areas. Our results were accomplished, due to smaller skin incisions, centered craniotomies, simulation of the surgical procedure (NSPS),functional mapping and intraoperative localization of the nidus, feeding arteries, draining veins and related neural structures.

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ROLE OF IMAGE GUIDED SURGERY IN THE RESECTION OF INTRAVENTRICULAR LESIONS

Federico C. Vinas, Lucia Zamorano, Zhaowei Jiang, Fernando G. Diaz
Wayne State University, Neurological Surgery Department, Detroit, MI

Introduction: Mass lesions located in the ventricular system can be surgically challenging. They are deeply located in the brain, surrounded by vital neurological and vascular structures, and often have irregular configurations. All these characteristics may pose real problems during surgery in terms of orientation and a optimal resection. Methods: We present our preliminary experience in the first 24 patients with lesions located in the lateral ventricles, third ventricle, and pineal region with intraventricular extension. For intraoperative real-time localization three infrared cameras continuously track the position of multiple light-emitting diodes in relation to a predetermined "rigid body", mounted in a fixed spatial relation with the patient's anatomy. This system can be used with different surgical instruments, and does not interfere with standard neurosurgical techniques. Patient follow-up period ranged from 2 to 24 months. All patients were followed clinically and with postoperative magnetic resonance imaging scans. Results: The use of interactive image-guidance surgery meant complete resection in 19 of 24 cases in this small series. In the remaining 5 cases, tumor adherence to the deep venous system or infiltration of internal capsule and midbrain were the limiting factors. We did not report any complication related to the surgical procedure. Discussion: The use of a system for interactive intraoperative localization during the resection of intraventricular lesions offers many advantages. Since the position of the instrument tip is displayed intraoperatively on the 3-D images, the system is useful in determining in real-time the geometry of the tumor, the margins of the surgical resection, and the vascular structures. Furthermore, this system is hands-free and can be used with multiple instruments, not interfering with any of the standard neurosurgical procedures. The integration of imaging with intraoperative physiological monitoring and interactive localization further improve the outcome in the resection of deeply-situated brain lesions, increasing surgical efficiency, without a significant increase in the length of resection.

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PERCUTANEOUS LASER DISC DECOMPRESSION (PLDD)- A NEW TREATMENT MODALITY FOR HERNIATED DISCS

Daniel S.J. Choy
Columbia University College of Physicians and Surgeons Laser Spine Center, New York

INTRODUCTION: - Previous surgical and chemical therapeutic interventions for herniated discs have all been based on *volume reduction* of disc. The author describes a relatively non-invasive, outpatient method using laser energy through a percutaneous needle to *reduce intradiscal pressure (IP)*.

First abroad, then in the U.S. after IRB permission, and then after FDA approval in 1991, the author applied these data in PLDD of 707 discs in 494 patients with a 11 1/2 year longest and an 80 month mean followup (FU), with a 25% loss of FU at 6 months, and a 4% loss at 1 year.

RESULTS - 707 discs in 494 patients (m=300, f=194), age = 17-92 were treated. There were 45 cervical, 5 thoracic, and 657 lumbar discs. Commonest:-C5-6, C6-7, L4-5, L5-S1. 74 pts. (74%) had multiple discs: 2 in 55, 3 in 15, 4 in 3, and 5 in 1 patient. There were 6 repeat PLDDs all because of re-injury. The overall seccess rate in 11 1/2 years according to the MacNab criteria was 75%, in the past 30 mos - 89%. 8% of all patients requird subsequent open surgery; 5% of these did not improve, and in 1/2, free disc fragments were found. The complication rate was <1.0%: septic discitis in 2 L disc pts. and 1 abscess in 1 C disc pt. All recovered with antibiotics. There were no other serious complications.

CONCLUSION-PLDD is effective with minimal morbidity and invasiveness, does not scar or cause soft tissue damage, reduction of disc height, narrowing of neural foraminae, or spinal instability, is an outpatient procedure, with local anesthesia, so that the risks of gen. anesthesia can be avoided, is repeatable, does not preclude possible future open surgery, is FDA approved and third party reimbursable, and offers another therapeutic modality to the patient with HNP disease who is reluctant to undergo open surgery.

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PERCUTANEOUS MICRODECOMPRESSIVE ENDOSCOPIC SPINAL DISCECTOMY WITH NEW LASER THERMODISKOPLASTY FOR NON-EXTRUDED HERNIATED NUCLEUS POLPOSUS (INTERVERTEBRAL DISCS) - 200 DISCS.

John C. Chiu, M.D., Thomas Clifford, M.D., Mark Greenspan, M.D., Felix Negron, M.D., Robert A. Princenthal, M.D., Joan Carter, R.N.

Our purpose is to demonstrate and to describe the collagen and disc shrinkage effect of Holmium laser at lower non-ablative energy level (laser thermodiskoplasty) with ease, safety and efficacy of this outpatient Holmium laser purcutaneous microdecompressive endoscopic spinal discectomy performed for symptomatic non-extruded herniated nucleus pulposus.

Between 1995 and 1997,125 prospective consecutive cases of 200 symptomatic spinal discs, despite at least 12 weeks of conservative treatment, were treated with purcutaneous microdecompressive endoscopic spinal discectomy and low level/non-ablative Holmium laser thermodiskoplasty, i.e.,collagen tissue and disc shrinkage/ tightening effect of Holmium laser.All cervical and lumbar herniated discs demonstrated unilateral radicular pain in a specific dermatome confirmed by EMG. MRI or CT scans demonstrated a contained soft intervertebral disc herniation in all cases.The demographics of the discs are 108 lumbar discs, 79 cervical discs, and 13 thoracic discs.

Postoperative follow-up demonstrates 95.2% (119 patients) of all patients were symptom-free.There were no intraoperative of postoperative complications. Two patients demonstrated persistent mild residual pain and paresthesia.The average time to return to work was two weeks for the non-workers' compensation patients. A computerized finite element model of the herniated disc pre and post laser discectomy with collagen tissue tightening or shrinkage, i.e., laser thermodiskoplasty at the collar and the shoulder of the disc is presented.It demonstrates the results of a computerized model for heat induced collagen tissue and the disc shrinkage and contraction for the purpose of disc decompression in spinal discectomy.

In conclusion this new Holmium laser thermodiskoplasty technique in laser purcutaneous microdecompressive endoscopic spinal discectomy appears to be easy, safe and efficacious.This less traumatic outpatient treatment leads to excellent results, with ease, faster recovery, and significant economic savings.

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HOLMIUM LASER (AT NON-ABLATIVE LOW ENERGY LEVEL) THERMODISKOPLASTY THROUGH DISK SHRINKAGE WITH TIGHTENING EFFECT.

John C. Chiu, M.D., Thomas Clifford, M.D., Mark Greenspan, M.D., Negron, M.D., Robert A. Princenthal, M.D., Joan Carter, R.N.

Our purpose is to demonstrate that the Holmium laser at lower non-ablative energy level caused a collagen/annulus fibrosis shrinkage with tightening effect in vitro and in vivo when applied to intervertebral disc tissue.

On cadaver intervertebral disc and pig intervertebral disc, Holmium laser

thermodiskoplasty or collagen tissue/disc shrinkage with tightening effect is performed and demonstrated. A computerized finite element model of the herniated disc pre and post laser discectomy with collagen tissue tightening or shrinkage, i.e., laser thermodiskoplasty at the collar and the shoulder of the disc is presented. It demonstrates the results of a computerized model for heat induced decompression in spinal discectomy.
Our results show that the amount of heat induced collagen/disc shrinkage (laser thermodiskoplasty) increased with lower level non-ablative dosage of laser energy (joules), compared with higher level ablative laser energy. Results of histologic examination revealed increased collagen hematoxylin uptake extending posteriorly. A computerized finite element model of the herniated disc and surrounding tissue demonstrates the collagen tissue and disc tightening effect of the lower level laser energy, for the purpose of disc decompression in spinal discectomy.
In conclusion the data and experiments support and confirm the concept of collagen tissue and disc shrinkage and tightening effect of the lower level non-ablative laser energy of Holmium laser (laser thermodiskoplasty), in a controlled fashion, in the surgery of spinal disc decompression.

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INTRACTABLE CERVICOGENIC HEADACHE SECONDARY TO HERNIATED CERVICAL DISC RELIEVED WITH PERCUTANEOUS MICRODECOMPRESSIVE ENDOSCOPIC CERVICAL DISCECTOMY WITH LASER THERMODISKOPLASTY 100 CASES.

John C. Chiu, M.D., Thomas Clifford, M.D., Felix Negron, M.D., Robert A. Princenthal, M.D., Joan Carter, R.N.

Our purpose is to demonstrate the safety, efficacy and technique of outpatient purcutaneous microdecompressive endoscopic cervical discectomy performed for intractable symptomatic cervicogenic headache secondary to cervical herniated nucleus polpusus. In addition, lower non-ablative Holmium laser energy has been applied for shrinkage and tightening effect on the disc further.
Between 1994 and 1997, 100 patients with symptomatic herniated cervical disc and headache who failed at least 12 weeks of conservative care were treated.Levels were C3 to C6, inclusive.All patients demonstrated unilateral radicular pain of a specific dermatome confirmed with EMG/ NCV. MRI or CT scans were negative for the brain but were positive for contained cervical disc herniation.Percutaneous microdecompressive endoscopic cervical discectomy technique is described with non-ablative lower Holmium laser energy was added for further disc shrinkage.
Our results show that after an average follow-up of 18.2 months (2 months to 36 months), 94% of patients were headache-free.There were no postoperative complications, except one mild diskitis treated with intravenous antibiotics with cure. Holmium laser at non-ablative lower Holmium laser energy has been utilized to shrink or to tighten the disc.Only two patients demonstrated frequent mild headaches and neck and upper extremity pain associated with paresthesia. Average time to return to work was two weeks for the non-workers' compensation patients.
In conclusion this technique appears to be easy,safe and efficacious for treatment of intractable symptomatic cervicogenic headache secondary to herniated cervical disc with purcutaneous microdecompressive endoscopic cervical discectomy with laser thermodiskoplasty.This less traumatic outpatient treatment with recently added non-ablative lower Holmium laser energy for disc shrinkage (laser thermodiskoplasty) leads to a definitive treatment and to a faster recovery.

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TRANSPINAL CANAL L5 S1 PERCUTANEOUS MICRODECOMPRESSIVE ENDOSCOPIC LUMBAR DISCECTOMY FOR NON EXTRUDED HERNIATED LUMBAR NUCLEUS POLPOSUS.

John C. Chiu, M.D., Thomas Clifford, M.D., Mark Greenspan, M.D., Felix Negron, M.D., Robert A. Princenthal, M.D., Joan Carter, R.N.

Our purpose is to demonstrate the safety, efficacy and technique of outpatient transpinal canal L5 purcutaneous endoscopic microdecompressive lumbar discectomy performed for symptomatic L5 lumbar herniated nucleus pulposus. Between 1994 and 1997, 44 patients who failed 12 weeks of conservative care were treated. All patients demonstrated unilateral radicular pain in the S1 dermatome, confirmed by EMG. MRI and CT scans demonstrated a contained soft L5 herniated disc. Conventional posterolateral approach for percutaneous lumbar discectomy could not be performed due to anatomical variations. Transpinal (extradural and transdural) L5-S1 percutaneous microdecompressive endoscopic lumbar discectomy approach was described and utilized. In addition, lower level non-ablative Holmium laser energy was applied for the purpose of disc shrinkage.
At an average follow up of 18.1 months (4 months to 36 months) there were no postoperative complications, except one patient who had a mild transient spinal headache for one day relieved with mild analgesics (Tylenol) Forty (95.5%) patients had symptomatic relief. Two patients (4.5%) demonstrated slight mild persistent low back and leg pain associated with some paresthesia. Average time to return to work was 10 days for the non-workers' compensation patient.
In conclusion this technique appears to be easy, safe and efficacious in selected herniated L5 Lumbar disc herniation. This approach makes an otherwise difficult of impossible percutaneous L5 discectomy by posterolateral approach possible through a transpinal canal (extradural and transdural) approach. This less traumatic outpatient treatment with added disc shrinkage from non-ablative low level Holmium laser energy leads to faster recovery and significant economic savings.

NEW DEVICES

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A CLINICAL AND HISTOLOGICAL PROSPECTIVE CONTROLLED COMPARATIVE STUDY OF THE PICOSECOND TITANIUM:SAPPHIRE (795 nm) LASER VS. THE Q-SWITCHED ALEXANDRITE (752 nm) LASER FOR REMOVING TATTOO PIGMENT

R. M. Herd, M. B. Alora, B. Smoller,* K. A. Arndt and J. S. Dover
Department of Dermatology, Beth Israel Deaconess Medical Center, Boston, MA; *Department of Pathology, Stanford University School of Medicine

It has been postulated that picosecond lasers should be more effective than the currently available nanosecond lasers in removing tattoo ink. In addition to thermal confinement, such pulse widths allow optimal photomechanical disruption of the target. The purpose of this study was to compare the efficacy of the picosecond titanium:sapphire (795 nm, 500 psec) laser vs. the Q-switched alexandrite (752 nm, 50 nsec) laser in the treatment of tattooed guinea pigs.
Four albino guinea pigs, each with 4 uniformly colored black tattoo spots measuring approximately 1 cm in diameter were treated. Three of the spots were divided into 2; one half was treated with the ti:sapphire laser and the other half with the Q-switched alexandrite laser. Fluences used for both lasers were 6.11, 4.24 and 2.39 J/cm^2 with spot sizes of 1.25, 1.5 and 2 mm respectively. The fourth spot was left untreated and served as control. Clinical evaluation and biopsies were performed at baseline, 11 and 16 weeks following a single laser treatment.
Greater clearance of tattoo was observed in ti:sapphire laser treated areas compared to the alexandrite laser treated areas. In some areas total clearing was observed after the single ti:sapphire laser treatment. No difference was noted between the 3 fluences used with either of the lasers. No scarring was present. Histological results showed similar

findings. Minimal fibrosis was seen in ti:sapphire treated specimens. Our findings suggest that the picosecond ti:sapphire laser is more effective than the Q-switched alexandrite laser in removing tattoo pigment and may be of significant clinical utility.

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SKIN COOLING CONSIDERATIONS DURING THE TREATMENTS OF LEG VEINS AND HAIR REMOVAL

Shahriar Ghaffari
OptoMed, Inc., Austin, Texas

Leg vein treatments and hair removal procedures have recently become possible with lasers and light sources delivering high fluences in the range of 20-50 J/cm^2. Delivery of high fluences requires skin cooling to remove heat, avoiding bulk tissue coagulation while reducing the associated pain. After the delivery of pulsed light, the peak temperatures produced below epidermis must be controlled, both in magnitude and depth, to produce consistent treatment results. The dynamic nature of the events requires a dynamic cooling system optimized for the treatment of leg veins and hair removal.

DermaCool™ is a pulsed skin cooling device to control peak temperatures, at the depths of 0.1-3 mm into skin, for leg vein treatments and hair removal applications. DermaCool uses a source of Tetrafluorethane cryogen (an environmentally friendly replacement for freon) to produce very rapid cooling of skin timed with the delivery of pulsed light. The direct spraying of the cryogen in some cases reduces the temperature of epidermis well below 4°C thereby resulting in epidermis reaction. Consequently, a sapphire lens or window, in contact with skin, is used to maintain and control the cooling rate and improve the homogeneity of cooling surface. Having considered the cooling parameters, DermaCool has been developed to improve the safety and efficacy of treatments while reducing pain. The optimization of light wavelength vs. Cooling rate vs. Cooling duration will be discussed.

DermaCool is a trademark of OptoMed, Inc., Austin, Texas (patent # 5344418).

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Use of the CLO Cutaneous Cooling Device.

The CLO device is used to assist any laser surgeon with both leg vein treatment using the pulsed-dye laser and hair removal with the LPIR laser. Before this cooling device, leg vein treatment with the pulsed-dye laser was impossible. However, the advantages of this skin cooling enables much greater laser power to be used without the poor sequelae. Furthermore, it works as an excellent immediate topical anesthetic.

The discussion will include what this cooling device is. How it works. Why it works. Why it is so advantageous to the surgeon. Concluding with examples of it being used.

Adam B. Bodian, M.D. - Director of Dermatologic Clinic
Western Queens Community Hospital

Attending in Medicine/Dermatology
North Shore University Hospital

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NEW COOLING TECHNIQUE FOR PULSED LASERS OR INTENSIVE LIGHT SOURCES

Hartmut Tiel[1], Michael Drosner[2], Thomas Hebel[2], Christian Raulin[3]
Lasercenters of Dermatology, [1]Berlin, [2]Munich, and [3]Karlsruhe, Germany

Though cooling devices are used, long pulsed lasers or intense light sources still cause moderate to severe pain and thermal side effects like hyper- or hypopigmentation and scars. To diminish pain and the risk of thermal side effects a new cooling method is introduced which could be used with almost all different types of pulsed lasers or intense light sources. A water based gel (ultrasound gel without optical refraction, ESC BVL coupling gel) is frozen in multiple small portions in a freezer (-4° C). The gel frozen like parfait is applied to a small area of the skin by a spatula ad should be left there for 10 seconds before the laser or light treatment begins. It gets transparent as soon as it is spread on the skin. Then the laser or light source hand piece is slightly placed on top of it with or without contact. This cooling technique diminishes pain and other thermal side effects and causes a considerable improvement of results. Additionally the frozen gel magnifies the target. Since the gel gets warm very quickly, be sure to restore it in the freezer and use a new deep frozen gel.

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TESTING METHODS for EXTRA OCULAR PATIENT EYE COVERS

David W. Stefanovsky, Luis Ruiz, R. James Rockwell, Jr.

Stefanovsky & Associates Inc., Lasemaster & Assoc, Rockwell Laser Industries, Inc.

Willowick, Ohio, Orlando, Florida, Cincinnati,Ohio

BACKGROUND: The use of a wide variety of lasers or laser types in Dermatologic and Plastic Surgery has increased over the last eight years. To assist in these therapies, intraocular laser eyeshields have been developed, tested, and used extensively in clinical conditions. However, the development of extraocular or periorbital patient eyecovers has not been emphasized.

Some have recommended black felt as an adequate eye protection for the patient undergoing facial laser surgery. Unfortunately, this material has been shown to be highly flammable following laser exposure. Others have used commercially available "suntan goggles" that have been laser impacted and tested by Drs. Dinehart and Davis from University of Arkansas, and Drs. Ries, Clymer and Reinisch from Vanderbilt University in Nashville, Tennessee However, these suntan goggles are not specified by the original goggle manufacturer for use as laser protection.

OBJECTIVE: The objective of this study was to test a new style of an extra ocular patient eye cover made of stainless steel and that has a matte finish. This presentation will outline the testing process that was used.

MATERIALS AND METHODS: The study was done using prototype stainless steel eyecovers. Temperature measurements following direct laser exposure were made using miniature thermocouple (k type) thermal sensors using a lubricating gel to enhance thermal contact. The probes were interfaced to an A/D converter and the output was recorded on a computer. The signals were digitized and the temperature-time history was outputted in a graphical representation. Standard radiometric equipment was used to quantitate the laser output. Lasers used in testing included a Trimedyne model 900 5 watt argon laser, Lasersonics model 250z 20 watt C02 laser, MBB Medilase 50 watt Nd:YAG laser, and a Candela SPTL IB Flashlamp dye laser.

RESULTS: During laser exposures, the temperature increased on an average of 10-35 degrees C over a 60 to 70 second exposure. The temperature increase was somewhat dependent upon the laser used. It was also directly dependent on whether or not wet cottonoids were placed under the eye cover during the test. Matte finish on the eyecover did diffuse the laser exposure. Suntan goggles that were laser impacted gave off an irritating odor, caused a flame to be emitted from center of top of goggle,and were completely burned through with a C02 laser. In comparison, black felt was immediatly vaporized.

CONCLUSIONS: The tested stainless steel eye covers did provide more than adequate thermal standoff for a maximum recommended exposure of 4 seconds which is typical clinical exposure. The largest temperature rise for the first 4 seconds of exposure was 5 to 10 aC. 60 second exposure produced maximum temperature changes. Moistened cottonoids caused temperature nearest skin to be relatively unchanged. Suntan goggles and black felt were deemed unacceptable for use as protection from a laser exposure.

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LASER SKIN RESURFACING USING A FREQUENCY-DOUBLED ND:YAG LASER AFTER TOPICAL APPLICATION OF AN EXOGENOUS CHROMOPHORE

C. Sumian, F. Pitre, B. Gauthier, M. Bouclier, S. Mordon
Cird-Galderma, Sophia-Antipolis & INSERM, Lille, FRANCE

Laser skin resurfacing is usually performed with CO2 or Er:YAG lasers. For these lasers, water is the main chromophore. Since frequency-doubled Nd:YAG lasers (532nm) are already used in Dermatology for angiodysplasias treatment, a new laser resurfacing method was investigated. In this study, epidermis ablation and dermis coagulation were quantified. This study was performed in vitro on human skin and in vivo on rat skin using a 532nm laser (P=2.7W, t=50-200ms) after topical application of an exogenous chromophore. Skin biopsies were taken to evaluate histological changes. Wound healing was followed up.

Using these parameters, ablation of epidermis was observed. The results showed that dermis coagulation depth increased as a function of exposure time. For 50ms, dermis coagulation depth did not exceed 60µm. Dermis coagulation depth reached 180µm for 200ms exposure time.

In conclusion, 532nm laser associated with an exogenous chromophore is an effective method for laser skin resurfacing. By selecting exposure time, dermis coagulation depth can be either the one observed with Er:YAG laser or the one obtained with CO2 laser.

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The Free-Electron Laser and Its Impact in Medicine

Lou Reinisch, *Department of Otolaryngology, Vanderbilt University Medical Center, Nashville, TN*

The free-electron laser (FEL) is a pulsed, tunable laser (typically within the infrared region of the spectrum) that has been extensively investigated for novel medical applications. The Vanderbilt FEL, for instance, produces micropulses with peak intensities of nearly 10 MW and can be tuned from 2.5 to 9.0 microns. The average intensity, however, is typically 0.5 W. The wavelength range of the Vanderbilt FEL allows investigators to target water molecules in tissue, bonds in the proteins of tissue, or bonds of exogenous substances, such as Teflon Research with the FEL has considered the laser for applications in many medical specialties, including dentistry, dermatology, neurosurgery, ophthalmology, orthopedics, and otolaryngology. This presentation will discuss the operation of the laser and consider some of the possible applications of the FEL. The status of the research will be reviewed. Critical evaluations of both potential and problems will be outlined.

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A COMPARISON OF SCAR REVISION WITH THE FREE ELECTRON AND CO_2 RESURFACING LASERS. June S. Chen, Lou Reinisch, R. Bruce Shack, John W. Zinser, Noah K. Weisberg, George P. Stricklin, and Darrel L. Ellis, Vanderbilt and Nashville VA Medical Centers, Nashville, TN.

Laser scar revision is currently done with the CO_2 laser at 10.6 µm, which ablates tissue by water absorption. To study the effects of targeting extracellular matrix protein vs. tissue H_2O, we compared the Free Electron Laser (FEL) used at 7.7 µm, (the amide III protein absorption band) to the CO_2 laser. Nude mice (N>12) who had rejected skin grafts on their dorsal surface and developed mature scars were used as a model for scar revision. One half of each scar was revised with either the FEL at 7.7 µm (38 mJ, non-overlapping spots delivered with a computerized adjustable pattern generator and 2-4 passes) or a 100 µsec CO_2 resurfacing laser (500 mJ, 5.0 Hz, and 2-7 passes). The other half of the scar was not revised, and served as a control. Photographic and histologic evaluation were done of the scars. Morphometric analysis was used to compare the data. Both the FEL and the CO_2 laser showed acceptable scar revision. Laser wavelengths preferentially absorbed by the proteins of the extracellular matrix (such as the FEL at 7.7 µm) may therefore prove to be beneficial for long term results in scar revision. Supported by Medical Free Electron Laser ONR grant N00014-94-11023 and NIH grant P30 AR41943.

NURSING/ALLIED HEALTH

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CURRENT ISSUES IN LASER THERAPY
Judy A. Chamberlain

To determine the amount of increase or decrease in the use of lasers in the operating room and other health care settings, as well as, the types of surgical survices and procedures being most frequently completed.
To identify the types of experimental procedures being investigated
To identify current roles of professionals involved in laser therapy.
To identify issues of most concern to laser safety officers

Written survey distributed to approximately 6000 laser professionals

Study currently in progress

It appears that there has been a resurgence of the use of lasers, and the laser has moved from the traditional operating room to other health care settings. Additionally, there has been an increase in thenumber of procedures being done by other than licensed physicians. It is desirable to determine the extent of these trends, and to examine the concommitant issues for those in laser safety officer positions.

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WHO IS DOING WHAT
WITH CUTANEOUS LASERS IN DENVER?
Denise Adams, RN, BSN, CNOR, Parker, CO
A written survey was mailed to 100 plastic surgeons, dermotologists, and ENT's in the Denver metro area. Denver is a median representative city in the United States in regards to population size and conservative medical procedures. The results

will determine who, if non-physicians are performing laser treatments. The survey will cover educational background, years of laser experience, types and number of laser procedures. Statistics of membership of ASLMS will be highlighted.

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THE NURSING ROLE IN THE USE OF PHOTODERM VL/PL
*TD Foster, MW Bell, MH Gold, Gold Skin Care Center, Nashville, TN
The Photoderm VL/PL is an intense pulsed light source being utilized by many physician groups at this time. In many states, the physicians utilize the nurse to perform an initial assessment, to perform the full treatment, and to follow-up patient evaluations and treatments when necessary. Therefore, nurses must assume new responsibilities including learning the physics of lasers and laser-light systems and being able to adjust the machine parameters appropriately to meet the needs of the individual patient. One of the major keys to Photoderm VL/PL's success results from having flexible light parameters so one may adjust the spectrum of light delivered, pulse timing and delay, and power supplied. These variables allow varicose and spider veins, port-wine stains, hemangiomas, telangiectasias, hyperpigmentation, including lentigines and melasma, as well as tattoos, to be treated successfully. This talk will review proper protocols utilized to allow the nurse to feel comfortable treating patients with the Photoderm VL/PL.

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A Case Report of Lidocaine Toxicity from Topical Administration of 40% Lidocaine Cream.
Dale P. Goodwin and Thomas O. McMeekin. Genesee Valley Laser Centre.
The use of topical anesthetic agents (Emla and Lidocaine topical cream) to alleviate pain from laser procedures has become standard practice. Enhanced absorption of these agents has been noted after occlusion and removal of the epidermis before application. The following case illustrates potential problems with this procedure. The patient is a 28-year-old female in good health who underwent Erbium Yag laser resurfacing for striae present about her breasts and abdomen. She had no intralesional anesthesia. The epidermis was removed with 3 passes of the Erbium Yag Laser at 3hz pulse rate. 40% Lidocaine Cream in acid Mantle base was then appied for 15 minutes with occlusion. The areas were then retreated at 10hz at 802mj for an additional 4 passes. 40% Lidocaine Cream in acid mantle base was applied post-operatively in a thin coating and occluded with a Telfa dressing to relieve burning and pain. The patient complained of post-operative dizziness in the first 30 minutes. This improved at approximately 1 hour post-op and the patient discharged. Please note her vital signs were normal and she was able to walk and drive on her own. Further dizziness persisted on her way home and she was sent to the Emergency Room for convalescence and evaluation. She was observed all night and hydrated with I.V. fluids. A blood level documented Lidocaine toxicity. Absorption and toxicity of Lidocaine will be reviewed. Guidelines for use and discharge evaluation by nursing will be addressed.

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COMPLICATIONS OF CUTANEOUS LASER RESURFACING: A NURSING GUIDE

Karin J. Formica RN, BSN and Tina S. Alster RN, BSN, M.D. Washington Institute of Dermatologic Laser Surgery and Georgetown University Medical Center, Washington, DC.

The objective of the presentation is to educate nurses in recognizing complications that can occur with cutaneous laser resurfacing. The development of high-energy pulsed or scanned CO_2 and erbium lasers for cutaneous resurfacing has led to safe and effective treatment of facial rhytides, atrophic scars, and other benign epidermal or dermal lesions. While excellent clinical results can be achieved, complications can potentially occur. Nurses must be able to identify problems early in order to reduce long-term side effects and complications. Postoperative skin care and management of laser-induced complications will be addressed.

90

LASER TREATMENT GONE BAD: UNNA'S BOOTS TO THE RESCUE

Julie Ellis RN Vanderbilt University Medical Center, Department of Plastic Surgery, Nashville Tennessee
The purpose of this presentation is to educate nurses about the potential problems and complications of treating spider veins with lasers, and alternative treatment options available. This is a case report of a forty year old female who developed eschar, and sloughed large areas of skin and dermis, post laser therapy of a vascular lesion. The primary treatment, was xeroflo, kerlix, and ace wrap. This method proved unsuccessful. We discontinued that treatment and applied Unna's boots with good results. After the first treatment the wounds were clean, and most of the eschar was gone. We observed early granulation tissue at the base of the large ulcer on the lateral aspect of the calf. In conclusion, we believe Unna's boots can be an effective treatment for laser related injuries of the lower extremities.

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PAIN MANAGEMENT FOR DERMATOLOGIC LASER SURGERY: A NURSING PERSPECTIVE

Kathryn Huber RN, BSN and Tina S. Alster RN, BSN, M.D. Washington Institute of Dermatologic Laser Surgery and Georgetown University Medical Center, Washington, DC.

The objective of the presentation is to inform nurses about the obligation to manage pain and decrease discomfort for patients undergoing laser surgery. Pain is a pervasive part of laser treatment and a problem with which nurses are expected to deal. Because patients differ greatly in their response to pain, several different approaches to pain management are necessary. Depending on the laser system used, the area of the body being treated, and the length of the procedure, effective pain management will vary. Preoperative, intraoperative, and postoperative pain management of patients will be discussed specific to a variety of laser procedures.

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PHYSICIAN AND ALLIED HEALTH TRAINING CONSIDERATIONS IN A MOBILE LASER PROGRAM: CAN WE MAINTAIN QUALITY PATIENT CARE?

Paul K. Plumb, Institute for Minimally Invasive Technologies, Abbott Northwestern Hospital, Allina Health System, Minneapolis, Minnesota

This study presents training recommendations and guidelines for physicians, allied health personnel and laser operators utilizing and delivering mobile laser services, discusses special considerations and challenges specific to the mobile laser environment and shares our initial three year experience in delivering lasers from a hospital-based mobile laser program. Rapid growth in the clinical application of laser technology, especially for cosmetic treatments is driving increased demand for mobile laser services. The generally high technology turnover risk and cost of lasers, along with the opportunity to differentiate services and gain a competitive advantage make rented mobile lasers attractive for many physicians in private practice. Unlike hospital-based laser programs, where credentialing policies for laser privileges are usually documented and enforced, few or none of these controls exist for clinics or private medical offices. Anecdotal reports of poor patient outcomes, complications and injury allegedly resulting from improperly trained physicians, allied health personnel or mobile laser representatives have been common. At least one consumer publication has included recommendations that patients should avoid physicians using rented lasers.

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BETTER PATIENT CARE THROUGH RESEARCH

Sharon Lee Polis RN, MS,
Vanderbilt University Medical Center
Department of Plastic Surgery
Nashville Tennessee

The objective of this presentation is to educate nurses and allied health professionals, concerning research projects. Topics include: (1) Who should do research (2) What topics to research (3) When to start a research project (4) Where to conduct your research (5) Why do research and (6) How to design a research protocol. Research benefits can and should include: improved patient care, discovery or confirmation of facts relating to your clinical practice, and validation of answers and/or questions affecting patient care. Clinical benefits can include expansion of skills such as interviewing, observation, psychological and physiological measurements. In conclusion, research can and should be used as a tool to render better patient care.

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THE NON-PHYSICIAN PROVIDING HAIR REMOVAL WITH LASERS AND HIGH ENERGY LIGHT SOURCE SYSTEMS

Mary Flor
Abbott Northwestern Hospital, Minneapolis, MN

This talk will discuss relevant treatment issues involving the topic of non-physicians using lasers and high energy light source systems for hair removal, the RN's role and responsibilities, plus how to develop a Hair Removal Center.

LIABILITY ISSUES
Definitions of liability issues, what determines those definitions, i.e., State laws, Board of Nursing and the Institute's policies.
What type of insurance coverage is necessary for the RN providing the care, and the physician responsible for the RN.
Establishing credentialing policies for the RN performing the treatment, and confirming the competence and experience of the responsible physician.

DEVELOPING A HAIR REMOVAL TREATMENT CENTER
The process of developing a Hair Removal Center includes:
Locating a site and determining the factors involved with that area.
Determine what staff qualifications are necessary to run a quality center.
Data collection from public/patient surveys are helpful when determining and providing desired treatments.
Developing policies and procedures that ensure quality treatment, safe patient care and compliance of all legal requirements.

THE NURSING FOCUS on HAIR REMOVAL TREATMENTS
Education, preceptoring with the physician until competency standards are met, and experience are key elements for the RN to work independently.
The total patient care experience: Pre-treatment assessment, patient teaching and consent, the treatment, and post-treatment follow-up instructions.
Documents for all patient visits and outcomes.

95*

EFFECTIVENESS OF FLASHLAMP PHOTODERM HR FOR HAIR REMOVAL

James Brazil, Patti Owens, William Reus, Authur Foley: Providence St. Peter Hospital : Olympia, Wa.

From July 1997 to October 1997, eligible patients were entered into a 6 month study using the ESC PhotoDerm HR Flashlamp for the investigation of long term hair removal. Protocol parameters were specified for the removal of all colors of hair, all body sites, and on skin types I through V. Filters 590 nm, 615 nm, and 645 nm were used with fluences of 30 to 50 J/cm2. Patients underwent 3 treatments at three week intervals. Sites were evaluated before each new treatment and then monthly at 3, 4, 5, and 6 months. Analysis of the treated areas as to hair regrowth, hair color and texture changes, and long term hair reduction will be presented. Variable results have been noted depending on hair color and location.

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EPIDERMAL TEMPERATURE DISTRIBUTION: DISCUSSION OF EPIDERMAL CONDITION WITH THE EPILIGHT™ HAIR REMOVAL SYSTEM

Kathy Rada, RN, Michael Kreindel, Ph.D., ESC Medical Systems, Needham, MA

The EpiLight™ Hair Removal System is an intense pulsed light device utilizing a broad band wavelength spectrum for photo-epilation. The system operates on the basis of selective photothermolysis, which selects optimal wavelengths range, pulse parameters and power profile to ensure that the depth of light penetration effectively destroys the hair follicle while sparing the epidermis and the surrounding tissue. The purpose of this study is to report the temperature distribution in the epidermis of skin types I-V and the associated side effects of photo-epilation treatment. A thermal model of the skin was developed to test the distribution of temperature of each skin type. A discussion of microscopic and macroscopic examination of animal and human histological effects will be reported. Epidermal side effects are significantly lower than other reported light-based modalities.

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EPILIGHT HAIR REMOVAL SYSTEM

SL Street, TD Foster, MW Bell, MH Gold, Gold Skin Care Center, Nashville, TN

The Epilight hair removal system is an FDA approved intense pulsed light source designed for long term hair removal. Through the process of selective photothermolysis, light is targeted to the hair follicle with destruction of the hair shaft and root. This is the newest treatment modality on the market for the removal of unwanted hair. Nurses and electrologists are taking a leadership role in many physician offices in launching this new technology for their practices. Besides learning the basic physics and mechanics of lasers and laser-like light sources, these specialists also must become competent at determining skin types as well as the proper texture and color of the hair to be treated. The proper use of this machine will be reviewed as well as data regarding its long term efficacy and safety. Nurses and electrologists will be major players with hair removal light systems.

OPHTHALMOLOGY

101*

OCULAR DISTRIBUTION AND EFFECTS OF PHOTODYNAMIC THERAPY WITH PURLYTIN ON FILTRATION SURGERY

RA HILL, DH Crean, PL Brennan, KQ Cheng, DA Lee, GB Primbs, LH Liah and MW Berns. UCI (RAH, LHL, MWB), UCLA (KQC, DAL), Miravant Med. Tech., Santa Barbara, CA (DHC, PLB, GBP)

We studied the distribution of Purlytin following sub-conjunctival (sc) injection and it's antifibrotic effects on filtering surgery. Rabbits (n=27) received sc injections of 10 (n=12) or 25 (n=12) ug 14-C labeled Purlytin; controls (n=3). Animals were sacrificed at 0, 1, 3 and 24 hr. Ocular tissue subcomponents were examined by liquid scintillation spectrophotometry. A second group of rabbits (n=24) underwent surgery followed by laser light (control group 1; n=5; 664nm; 100 mW/cm2; 30 J/cm2), surgery 1 hr after sc injections of Purlytin (control groups 2 and 3; 10 and 25 ug; n=5 and 4), or surgery after Purlytin injections (PDT groups 4 and 5; 10 and 25 ug; n=5/group) followed by laser light. Photic shielding limited tissues exposed. Tissues drug levels were sclera $>$ conjunctiva $>$ cornea $>$ iris $>>$ retina $>$ lens $>>$ aqueous & vitreous with significant levels reached at 3 hr in cornea $>$ iris $>$ retina. Filtering surgery survival was significantly extended in the PDT groups ($p<0.05$) and lid edema and corneal neovascularization were decreases by shielding. Purlytin distributes rapidly to target tissues; filtering surgery appears safe and effective with Purlytin. Surgery should be done before biodistribution to nontarget tissues. R43 EY11212-01A1, DOE-FG03 91 ER 61227, NIH RO1CA32248, NIH RO1192

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Clinical Trial of Diode Laser in Central Serous Retinopathy (CSR): A Safe alternative to Argon laser.

Lalit Verma, Pradeep Venkatesh, H.K. Tewari, Rajesh Sinha.
Dr. R.P.Centre for Ophthalmic Sciences, AIIMS, New Delhi-110 029, India

CSR may be primarily a choroidal disease and so we hypothesized that diode laser with its deeper penetration may be a useful alternative to argon laser in treating such patients.

To test the hypothesis we prospectively analysed the results of diode laser treatment in 20 patients of CSR in whom laser treatment was indicated. We evaluated the visual acuity, fluorescein angiographic leak and Amsler charting.

92% of cases showed absence of leak on FA, 4 weeks following therapy and scotomas resolved in all on Amsler charting.

We conclude that diode laser is a safe and effective alternative in CSR management and may be the preferred modality considering other well known advantages of diode laser.

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LASER ASSISTED CATARACT EMULSIFICATION (LACE) - CLINICAL RESULTS IN MORE THAN 50 PATIENTS

Colette Cozean, Ph.D., Irvine, California
Garth Stevens, M.D., Medical College of Virginia

Fifty-four patients diagnosed with cataracts with best corrected vision of less than or equal to 20/50 were surgically treated using the LACE procedure. The Er:YAG laser (2.9μ) provided the energy source for two different techniques -- a unimanual technique in which lasing, irrigation and aspiration were integral to one handpiece with an outer diameter of 2 mm and a bimanual technique in which the laser energy eminated from a single handpiece with the irrigation and aspiration provided through a second portal.

Visual acuity, intraocular pressures, corneal clarity, anterior chamber reaction and angle, retinal pathology and endothelial cells counts were measured pre-operatively and at follow-up examinations ranging up to 6 months. No laser related operative or post-operative complications were noted during the course of the study. As the study progressed, a large proportion of the cases were completed using only the laser instead of utilizing the laser to soften the nucleus prior to the phacoemulsification

The laser handpiece is light and well balanced with a smooth olive shape tip. Dense cataracts are emulsified more effectively, which is one of the shortfalls of ultrasonic phacoemulsification devices.

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IR LASER SURGERY TREATMENT OF CATARACTOUS HUMAN LENS MONITORED BY OPTICAL COHERENT TOMOGRAPHY

V. Kamensky, Novgorod, Russia

We show that Optical Coherent Tomography (OCT) enables one to follow the pulse-to-pulse kinetics of laser interactions with turbid biological tissues when control by usual optical techniques is hindered by light scattering. A pulsed midinfrared lasers are used clinically for ablation of biological tissue. Ablation of a human lens is investigated as a method to perform cataract surgery through small incision. Such a technique would ablate nuclear material with preservation of the capsule bag. In comparison with the ultrasonic method , the laser technique allows one to ablate harder crystalline lens.

We investigate the effect of mid IR radiation of different wavelengths on a cataract-suffered human lens *in vitro*. The future development of OCT facilities and effective radiation fiber delivery systems promises the creation of effective instrument for cataracted lens surgery through small incision.

A cataractous human lens contains up to 70-80 % of water. In our experiments, we use the laser radiation of different wavelengths corresponding to different initial water absorption coefficients α. A YAG:Er laser with wavelength $\lambda = 2.94$ μm ($\alpha \sim 10^4 cm^{-1}$), a YAG:Nd laser with $\lambda = 1.44$ μm ($\alpha \sim 30\ cm^{-1}$). Due to the significant difference in the absorption length of radiation in water, the ablation and tissue modification processes are very different.

We discuss the results of OCT investigation into the pulse-to-pulse kinetics of laser ablation crater growth, hump creation, collagen denaturation, and tissue drying phenomena. Different regimes of laser ablation and preablation tissue transformations are monitored *in situ*.. This knowledge is of great importance for optimization of laser surgery treatment of operated tissues.

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THE HISTOLOGICAL EFFECTS OF THE CARBON DIOXIDE LASER ON IN VIVO EYELID TISSUE

Mark A. Baskin, M.D., F.A.C.S., Encino, California

Patients undergoing routine blepharoplasty surgery volunteered to be treated with carbon dioxide laser spots of equal fluence and varying degrees of overlap in order to determine the ablative and thermal effects on in vivo eyelid skin. Following skin excision, punch biopsies were examined and depths of ablation and thermal injury were measured. As the degree of density increases the depth of ablation and the extent of thermal injury both increase.

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CO2 ULTRAPULSE LASER THERAPY OF XANTHELASMA

Geva Mannor, Mt. Sinai Hospital, New York, NY
Ira Wallace, Scheie Eye Institute, Philadelphia, PA

We sought to improve the aesthetic outcome of periorbital tumor excision by utilizing a CO2 ultrapulse laser which delivers energy at very high peak powers for extremely short duration thus limiting collateral thermal damage and tissue charring. Similar laser fluence was achieved with either a 2.25 mm spot size at 200 mJ energy or a 3.0 mm spot at 500 mJ energy (computerized pattern generator) with 10% overlap in up to 3 passes. 14 xanthelasma lesions ranging in size from 2 to 3.5 cm^2 in 4 lids of 2 patients (including medial canthus) were treated with topical or local anesthesia in an office setting. At 6 months follow-up, cosmetic results were judged as satisfactory in all patients. There was no recurrence, no residue, no skin shortage, no scarring and no pigmentary abnormalities. In addition, no perioperative pain was reported by patients. Patients were extremely satisfied with their final cosmetic appearance and greatly appreciated the lack of traditional scalpel cutting and suturing. Laser resurfacing of such tumors is optimal because the laser allows excellent hemostasis, avoids scalpel incision and suturing, obviates the need for reconstruction, diminishes potential postoperative skin shortage (webbing or ectropion), minimizes scarring and enhances the aesthetic outcome.

Resurfacing lasers should be considered by surgeons desiring to remove benign periorbital lesions when a biopsy is not indicated.

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***IN VIVO* EYELID PERFUSION VIA LASER DOPPLER**

Geva E. Mannor, Mount Sinai Hospital, New York, USA
Karin Wardell, Linkoping University, Linkoping, Sweden

While the arteriolar anatomy of human eyelids is well established, eyelid cutaneous microvascular blood flow is not. Laser Doppler flowmetry is a recent, effective and non-invasive method to study microcirculation. Eleven normal subjects without prior medical or surgical history, or eyelid malposition, underwent laser Doppler perfusion scanning of six skin locations: right forearm, right middle fingertip, right upper eyelid, right lower eyelid, left upper eyelid, and left lower eyelid. All subjects had stable hemodynamic measurements and were examined in similar room temperature and ambient lighting. A mean of several hundred measurements in each location was obtained and compared with the means of the other locations via Student's t-test. Cutaneous perfusion in the four lid locations and in the fingertip were statistically similar to each other but significantly higher than that of the right forearm ($p=0.002$). Also, mean perfusion in *pretarsal* skin was more than *50% higher* than in *preseptal* skin ($p=0.002$). Furthermore, in an eyelid with histopathologically-documented basal cell carcinoma, cutaneous perfusion was significantly higher than the mean of the normal eyelids ($p=0.001$). Eyelids are perfused at the same high caliber as other high flow regions of the head and neck and significantly higher than low flow regions such as the extremities. Perfusion imaging enables postoperative monitoring of periorbital grafts and flaps. This technique may also distinguish between benign and malignant adnexal skin lesions.

OPTICAL DIAGNOSTICS

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REAL TIME LIGHT INDUCED FLUORESCENCE ENDOSCOPY (LIFE) IN THE GASTROINTESTINAL (GI) TRACT

GA DuVall[1], R Saidi[1], J Kost[2], D Scheider[1], L Lilge[2], M Cirocco[1], S Hassaram[1], H Ter[1], G Kandel[1], P Kortan[1], G Haber[1], T Mang[2], R DaCosta[2], BC Wilson[2], N Marcon[1].The Wellesley Hospital[1] and The Ontario Cancer Institute[2], Toronto, Canada.

BACKGROUND: Light induced fluorescence point spectroscopy of the GI mucosa can differentiate normal mucosa from dysplasia/carcinoma and identify dysplastic lesions occult to routine white light endoscopy (RWLE). The purpose of this study was to determine if a real time LIFE imaging system of the GI tract (Xillix-LIFE, Vancouver) could differentiate normal mucosa from dysplasia/carcinoma. **METHODS**: 102 pts (59 male, mean age 65) consented to fluorescence imaging performed during routine colonoscopy(59) and gastroscopy (43). All procedures were documented with video and still images. In addition to RWLE, all mucosal abnormalities were examined with fluorescence using 437nm excitation. The images were reviewed separately by two endoscopist (GAD, RS) and the fluorescence was classified as a positive 'red' or a negative 'green' when compared with the normal 'green' surrounding mucosa. Tissue was obtained from the lesions and adjacent normal mucosa. In a blinded fashion, each sample was assigned a specific numerical diagnostic code by a single pathologist (1-4 denoting non-neoplastic changes, 6-9 neoplastic, and 5 atypia of undetermined significance). The sensitivity/specificity of the Xillix-LIFE system was calculated by correlating the positive and negative fluorescence readings to the pathology codes. **RESULTS**: All lesions noted on RWLE were also seen using the Xillix-LIFE imaging system. Two high grade dysplastic lesions occult to RWLE, one in the colon of a pt with familial cancer syndrome and one in a Barrett's esophagus, were found only by fluorescence. Given the inconsistency of the current 'gain' standardization technique used for Barrett's esophagus, all cases of Barrett's esophagus without obvious carcinoma were excluded from the present analysis. The combined two-observer sensitivity/specificity for atypia or a higher grade lesion was 83%/84% and 87%/79% for the esophagus and colon, respectively. **CONCLUSION**:The real time Xillix-LIFE imaging system can screen the entire mucosal surface accurately differentiating normal from dysplasia/ carcinoma and target occult dysplastic lesions for directed biopsies. Further investigation is needed in the surveillance of Barrett's esophagus with fluorescence. Multi-center trials are needed to establish the clinical utility of fluorescence imaging in pts at high risk for GI cancer.

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FACTOR ANALYSIS OF CANCER FTIR-FEW SPECTRA

Sydney Sukuta[a], Lixing Ma[b], Reinhard Bruch[a], Natalia I Afanasyeva[c], Sergei F. Kolyakov[c], Leonid N. Butvina[d].

[a] Department of Physics, University of Nevada Reno, Reno NV.
[b] Department of Computer Science, University of Nevada Reno, Reno NV.
[c] Institute of Spectroscopy, Moscow Region, Russia
[d] General Physics Institute, Moscow Russia..

The purpose of this study is to isolate and identify pure biochemical components in skin cancer. Factor Analysis (FA) is employed to analyze Fourier Transform Infrared Fiberoptic Evanescent Wave (FTIR-FEW) spectra in the middle infrared. FA is a mathematical-statistical method for solving multivariate problems. FA yielded the optimal number of infrared active biochemical pure components and isolated their spectra without assuming any mathematical fitting function(s). The identities of the principal biochemical species/components is then attained via target testing or rotation. Cancers studied are basaloma and melanoma. Our results strongly suggest that Amide I and Amide II, and hydrogen bonded carbonyls are the most active species. This study demonstrates the potential of using FA, a purely mathematical-statistical route, as an alternative to attaining chemically meaningful or diagnostic information from intact tumors without being invasive.

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INHALATION OF 5-AMINOLEVULINIC ACID FOR ENDOSCOPIC DETECTION OF LUNG CANCER

R. Baumgartner, H. Stepp, J. Pichler, H. Schulz[1], R. Huber[2], K. Häussinger[3]
Laser-Forschungslabor, Urologische Klinik der LMU München
[1] Institut für Inhalationsbiologie der GSF, [2] Medizinische Klinik Innenstadt, [3] LVA Krankenhaus Gauting

Early detection of lung cancer is of favoured interest for clinicians especially in case of a positive sputum cytology and no incidence of disease during routine white light bronchoscopy.
Since 5-aminolevulinic acid (5-ALA) has been proven to induce

selective generation of fluorescent Protoporphyrin-IX (PPIX) in bladder cancer, the method has been transfered to cancer in the tracheobronchial tree.
For fluorescence bronchoscopy 5-ALA was inhaled by patients with use of a special nebulizer which allowed a homogeneous deposition of 5-ALA on the bronchial mucosa. Fluorescence of PPIX was excited by violet-blue light of a Xe-lamp (D-Light, Storz, Germany) and detected endoscopically either with the naked eyes or with use of an adapted highly sensitive color CCD-camera. Preliminary clinical results show a high capacity of normal bronchial epithelial cells to synthesize PPIX and an only low tumor to normal tissue ratio of about 3.
To enhance this value we tested a combination of PPIX fluorescence with tissue autofluorescence emitted in the green spectral range. Since the autofluorescence intensity is reduced in severe dysplasias and carcinoma in situ contrast enhancement is expected by image processing.
Clinical trials have now started to evaluate sensitivity and specificity of 5-ALA assisted fluorescence bronchoscopy.
The study is supported by the BMBF under grant number 13N6311

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OPTICAL DIAGNOSTIC METHOD FOR LASER ASSISTED CARTILAGE RESHAPING, B.J.F. Wong[1,2], J. DeBoer[1,3], T.E. Milner[1,4,5], H.H. Kim[1], and E.N. Sobol[6], [1]Beckman Laser Institute and Medical Clinic, University of California, Irvine, [2]Department of Otolaryngology- Head and Neck Surgery, University of California, Irvine, [3]Laser Center, Academic Medical Center, University of Amsterdam, 4Harvey Mudd College, [5]Bioengineering Program, University of Texas at Austin, [6]Center for Technological Lasers, Russian Academy of Sciences

In this study, we investigate the temperature dependent changes in the optical properties of porcine nasal septal cartilage during slow heating. Individual cartilage specimens were suspended in saline solution within a Rose chamber, (secured to the a laboratory hotplate). Chamber temperature $\mathbf{T_c(t)}$ was measured with a thermocouple. The chamber was heated from ambient (22° C) to various endpoint temperatures $[\mathbf{T_f}]$ (50-80 °C) over 30 to 180 minutes. During heating, backscattered light from an amplitude modulated (10 kHz) HeNe laser (λ=632.5nm, 5 mw) incident on the cartilage was collected in an integrating sphere and synchronously detected by a lock-in amplifier in combination with a silicon photodiode to yield integrated back scattered light intensity $[\mathbf{I(t)}]$. Fractional change in integrated back scattered light intensity $[\Delta\mathbf{I(t)/I_0}]$ was calculated ($\mathbf{I_0}$ is the baseline light scattering signal prior to heating). For $\mathbf{T_f}$ greater than 55°C, $\Delta\mathbf{I(t)/I_0}$ reaches a maximum, attains a plateau, and then decreases monitonically while $\mathbf{T_c(t)}$ continues to increase. When $\Delta\mathbf{I(t)/I_0}$ is in the plateau region $\mathbf{T_c(t)}$ is approximately 55-60°C, though the transition temperature varies with the rate of heating. When $\mathbf{T_f}$ is below 55°C, $\Delta\mathbf{I(t)/I_0}$ attains a plateau without a subsequent decrease, despite prolonged heating. These findings are consistent with previous observations on the transition temperature for laser induced stress relaxation in cartilage, and further suggest that the observed changes $\Delta\mathbf{I(t)/I_0}$ are a result of a time-temperature dependent process of protein denaturation in cartilage tissue.

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Photothermal Imaging of in-vivo Microvasculature Following Pulsed Laser Irradiation

S.A.Telenkov, D.M.Goodman*, J.S.Nelson and T.E.Milner
Beckman Laser Institute and Medical Clinic, University of California, Irvine, CA, USA
*Lawrence Livermore National Laboratory, University of California, Livermore, CA, USA

Abstract

We present tomographic images of in-vivo chick chorioallantoic membrane (CAM) blood vessels heated by pulsed laser irradiation (λ= 532-585 nm, τ = 0.5-10 ms). The temperature increase in subsurface blood vessels in response to pulsed laser irradiation was analyzed using a high speed IR focal plane array camera. The initial three-dimensional temperature distribution in the CAM immediately following pulsed laser irradiation was computed utilizing a tomographic reconstruction algorithm. The thermal response of the CAM vasculature to laser pulse durations 0.5-10ms is presented. Infrared data provide consistent estimates of the physical dimensions and thermal relaxation time of subsurface blood vessels.

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Estimating laser parameters for dermal blood vessel destruction by employing color Doppler optical coherence tomography
Jennifer K. Barton, T. Joshua Pfefer, Joseph A. Izatt, Ashley J. Welch (Univ. of Texas at Austin, Austin, TX)
(JAI, Case Western Reserve Univ., Cleveland, OH)

Laser treatment of cutaneous vascular disorders may be improved by developing a customized treatment strategy based on the patient's blood vessel structure. This approach requires both that the blood vessels be mapped and that optimum laser parameters be related to blood vessel information. We demonstrate the feasibility of estimating laser parameters for dermal blood vessel destruction through the use of color Doppler optical coherence tomography (CDOCT), the hamster skin flap model, and optical Monte Carlo modeling.

CDOCT is an extension of optical coherence tomography which incorporates coherent signal acquisition electronics and joint time frequency analysis to perform spatially localized flow imaging. Since the most obvious source of motion in skin is flowing erythrocytes, CDOCT is an ideal method for identifying blood vessels.

For a given laser wavelength, pulse duration, and spot size, the fluence required to coagulate exposed vessels on the window side of the model was determined experimentally. Threshold fluence varied with type and size of vessel.

We performed CDOCT mapping of subdermal blood vessels with 25 micron resolution in skin flap models. Three dimensional CDOCT image sets were simplified and used as input to a flexible geometry optical Monte Carlo model. Laser parameters were calculated which produced threshold fluence at the blood vessel walls when the epidermal side of the model was irradiated. Calculated laser values compared favorably with actual parameters required to destroy the mapped blood vessels.

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Two-dimensional birefringence imaging in biological tissue using polarization sensitive optical coherence tomography

Johannes F. de Boer[a], Thomas E. Milner[a], Martin J. C. van Gemert[b], and J. Stuart Nelson[a]

[a] Beckman Laser Institute and Medical Clinic, University of California at Irvine, Irvine, California.
[b] Laser Center, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

Polarization Sensitive Optical Coherence Tomography (PS-OCT) is a non-contact non-invasive technique to image tissue birefringence with high spatial resolution. Two-dimensional maps of birefringence can reveal important structural information that is difficult to resolve with other imaging techniques. Partial loss of birefringence is known to be an early indication of tissue thermal damage. PS-OCT uses the partial coherence properties of a light source in a polarization sensitive Michelson interferometer. Detection of the polarization state of the signal, formed by the interference of backscattered light from the sample and a mirror in the reference arm, gives the optical phase delay between light that has propagated along the fast and slow axes of the birefringent tissue. We present two-dimensional images of the change in polarization of circular polarized light backscattered from a turbid birefringent biological sample. Images of bovine tendon before and after laser irradiation show the decrease of birefringence in the irradiated zone due to thermal damage. PS-OCT has the potential to provide guidance regarding optimal dosimetry for thermally mediated laser therapeutic procedures by permitting real-time diagnostics at each irradiated site through detection of changes in birefringence associated with thermal damage and pathological conditions.This would permit a semiquantitative evaluation of the efficacy of laser therapy as a function of incident light dosage.

ORTHOPEDIC SURGERY

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PRELIMINARY REPORT: DEVELOPMENT OF A COST-EFFECTIVENESS STUDY MODEL FOR HOLMIUM LASER ARTHROSCOPY

Paul K. Plumb,Institute for Minimally Invasive Technologies, Abbott Northwestern Hospital,Allina Health System, Minneapolis, Minnesota

This preliminary report presents results of a study undertaken to design a model to evaluate the cost-effectiveness of Holmium laser when utilized in arthroscopic surgical procedures. In all sectors of the health care industry, organizations are being asked to demonstrate the value of the products or services they provide. Some regulatory agencies have begun to include cost-effectiveness data as a prerequisite to product or reimbursement approval. Although financial materials, promoting the income potential of a particular laser device or other return on investment data are commonly available through device manufacturers, little has been published to date on comprehensive evaluation of laser cost-effectiveness. Decisions to purchase laser devices historically have been driven by promotional value, perceived competitive need, anecdotal or published patient outcomes, and patient demand, among others. Financial realities in health-care today dictate, especially to the hospital/provider, that we are able to assess and present cost-effectiveness data in a manner that can be understood by providers, payors, industry, and the community served.

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DELAYED BONE HEALING OF SCAPHOID FRACTURE TREATED WITH LOW ENERGY LASER THERAPY: A CASE REPORT

Marcos Gruszka, Walter Amryn and Rebeca Fiszerman.
Clínica Villa Gessell and Buenos Aires Laser Center, Argentina.

Previous studies have shown that bone fractures healed faster with low energy laser irradiation.
A 20 years old man presented delayed bone healing of scaphoid fracture after 18 months injure. He refused surgery treatment and bone graft. The patient reported pain during active and passive movement and pressure of the wrist.
The carpale region had been treated with low energy GA-AS laser 904 nm wavelenght with 9 Joules/cm^2 and 0,9 Joules/cm^2 energy density on each point, 20 points, 3 times weekly during 3 months. After 43 treatment days (20 sessions) pain had relieved and movement had improved.
Results: after treatment radiological studies showed fracture consolidation, pain relieves and wrists movements were normal.

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COMBINED EFFECT OF LASER, ULTRASOUND, AND ELECTRICAL STIMULATION ON TENDON HEALING

G. Kesava Reddy, Lisa Stehno-Bittel, and Chukuka S. Enwemeka

Department of Physical Therapy, University of Kansas Medical Center, 3901 Rainbow Blvd., Kansas City, KS 66160-7601

Previous studies have shown that laser, ultrasound and electrical stimulation independently accelerate the tissue healing process. It may be possible that a combination of these physical modalities produce more beneficial effects than each modality. Therefore, the purpose of this investigation is to examine the biomechanical, biochemical, and ultrastructural effects of a multitherapeutic protocol on surgically tenotomized rabbit Achilles tendon. The therapy was composed of low-intensity Ga:As laser photostimulation, low intensity ultrasound, and electrical stimulation. The Achilles tendon of 45 male New Zealand rabbits were tenotomized, sutured, and subjected to the multitherapeutic protocol for a total of five days, after which casts were removed and the therapy was continued for nine days without electrical stimulation. The tendons were excised, and compared to control tendons in terms of their biomechanical and biochemical characteristics, including collagen production and collagen crosslinking, maximum load, load at break, maximum displacement, displacement at break, maximum stress, stress at break, maximum strain, strain at break, Young's modulus, area, energy to yield, and energy at break. Whereas the multitherapy protocol produced minimal to moderate biomechanical effects on the repaired tendons, there was a statistically significant increase in collagen production following treatment. Because of the possible shear force of electrical stimulation the experiments were repeated without electrical stimulation and similar results were obtained. The results lead to the suspicion that the beneficial effects of laser stimulation and ultrasound on tendon healing may counteract one another when applied simultaneously. In conclusion, our findings indicate that following tenotomy and repair of the rabbit Achilles tendon, a combination of Ga:As laser photostimulation, therapeutic ultrasound, and electrical stimulation enhance collagen synthesis without significantly altering the ultrastructure of the collagen, the biomechanical characteristics of the tissue, or the production of mature cross-links in the collagen macromolecule.